COMPARATIVE STUDY ON SAND SPIT MORPHOLOGY CHANGE IN JAPAN

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1. INTRODUCTION

The Sagami River mouth and the Ohyodo River mouth, both bounded by two jetties, have experienced sand spit recessions in recent years (Kawamura and Tanaka, 2005). The constructions of several coastal structures are supposed to be one cause of the sand spit recession at the Sagami River mouth. For the Ohyodo River mouth, the construction of Miyazaki Airport is supposed to be the main factor of the sand spit decline.

In the present study, traditional aerial photograph analysis methods, which consists of tracing shoreline positions on digitized photographs, is used to quantify the morphological change of the river mouths. Special focus is taken on the decline of the sand spit.

2. METHODOLOGY

Fourteen and nine aerial photographs are collected for the Sagami River mouth and the Ohyodo River mouth respectively. For the rectification, Ten Ground Control Points (GCPs) are located with Japan Map in Geodetic system which has an interval of 0.05 second or 2.0 meter approximately. The coordinates of the GCPs are converted to JGD2000/Japan Plane Rectangular CS-X system which expresses in meter. Because of the small scale of the study area, the 1st-order transformation or linear transformation is applied. The results show an average Root Mean Square (RMS) error about 3.02m and 3.7m for each river, respectively.

Many papers have been published dealing with the measurement of beach recession and almost exclusively these papers have dealt with trend measurement using indicators such as shoreline (Hanslow, 2007). Chen and Chang (2009) pointed out that shoreline position changes continually with time because of beach variation that results from on-offshore and alongshore sediment transport. The dynamic nature of water levels, such as waves and tides, causes also shoreline position variation. Because of the dynamic nature of the idealized shoreline boundary, for practical purposes, coastal investigators adopt the use of shoreline "indicators". Individual shoreline indicators generally fall into two categories: a feature that can be physically seen in coastal imagery, for example, a previous high-tide line or the wet/dry boundary; or a tidal datum-based indicator which is determined by the intersection of the coastal profile with a specific vertical elevation, for example, mean high water (MHW) or mean sea level (MSL) (Boak and Turner, 2005). In the present study, the mean sea level is expected to be the shoreline indicator. However, it is not a feature that can be directly seen from the photographs. The wet/dry boundary is therefore chosen as the alternative indicator (Fig.1). The extracted shoreline position with this line will need to be shifted to the MSL-datum-based shoreline position by using tidal stage and wave run up.

The shoreline "position" is, in fact, the distance between the shoreline and the baseline defined parallel to the shoreline (Fig.1). The portion of shoreline being studied is divided into sections of 20 meters. Thus the shoreline position is recorded every 20 meters. The alongshore distance from the left is noted L. For the Sagami River mouth, the portion between L=1920m and L=2360m is considered as the sand spit (Fig.1). For the Ohyodo River mouth, the portion between L=1400m and L=2000m is considered as the sand spit.

Fig.1 Baseline, transect and sand spit at the Sagami River mouth

The local slope, noted α_b, is assumed equal to 0.04 based on the general relationship between beach slope and grain diameter in Reeve (2004). Owing to the lack of detailed wave data, corrections are made without taking account wave run up. Thus, the corrected shoreline position is given by:

$$Y = Ym + h_{TD} / \alpha_b \quad (1)$$

where Ym is the measured shoreline distance in meter, h_{TD} is the height of tidal stage in meter and Y is the corrected shoreline distance in meter.

3. RESULTS AND DISCUSSIONS

For each of the photographs at each river mouth, the shoreline positions is measured and corrected by the method mentioned above. The results are plotted in Fig. 2 and Fig.3 for each river respectively. The lengths of several typical transects crossing the sand spit, including the left border and the right border, are presented with different forms and colors. Except the two borders at the Sagami River mouth, the transect is distanced 100m one another. The evolutions of nearby costal structures are also shown on the graphic, taking account of their distances to the river mouth.

The morphology of the Sagami River mouth had been stable until the 1970s. However, from 1983 to 2001, the sand spit migrated into the river more than 200m. Especially during the period from 1983 to 1993, the migration extent was as much as 175m.

In near place, a sea wall (SW), a breakwater (BW) and a headland (HL) were constructed in the 1980s and extended later. Two kilometers further, a groin (GR) was built up since the 1960s. The sea wall, the breakwater and the headland are supposed not to have considerable impact to sediment transport in view of

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their orientation which is parallel to the shoreline. But the groins, constructed perpendicularly to the shoreline, may influence the alongshore sediment transport and cause the sand spit decline in long time scale, despite of its far distance with the river mouth. After being constructed in the 1960s, it had been lengthened around 150m by 1983 and a second groin was added in parallel at the same time. From this year, the sand spit began to migrate into the river with significant speed.

Similarly, the Ohyodo River mouth had also stayed stable for a long time till the 1970s. From 1986 however, the sand spit began to retreat into the river. Up till 1990, it had migrated as much as 200m. By 1994, it had disappeared completely. Unfortunately its evolution process from 1990 to 1994 has not been observed in the present study due to the lack of data source.

The Miyazaki airport, one kilometer away to the west of the river mouth and constructed in the end of the 1960s, was extended nearly 300m in seaward direction with two groins. This extension project was launched early 1980s and accomplished by 1986. As mentioned above, 1986 is also the year from which the sand spit started its migration, according to the aerial photographs. The construction of the groins is supposed to be the main factor that caused the sand spit retreat and made it disappear.

On the other hand, from the beginning of the airport extension project, it had only taken 5 - 6 years for the river mouth to begin its morphology change. This time gap is much shorter than that of the Sagami River mouth, at which the first stage of sand spit migration is observed around 1983, twenty years after the construction of the groin. This difference in terms of time is supposed to relate to the distances between the river mouths and the coastal structures.

Furthermore, the groins of the Miyazaki airport are nearly 300m in length, two times of the groins near the Sagami River mouth, which also should have caused the difference response speed of the two river mouths.

4. CONCLUSION

In the present study, available aerial photographs have been used for measurement of long-term morphology change at the Sagami River mouth and the Ohyodo River mouth. The results showed that the sand spit at the Sagami river mouth declined more than 200m from 1960 to 2001. At the Ohyodo River mouth, the sand spit has also declined more than 200m from 1983 to 1990 and disappeared from then on. The nearby coastal structures are supposed to have contributed to the decline of the sand spits. Further more, it is supposed that the response speed of river mouth morphology depends on the distance between the river mouth and the coastal structures.

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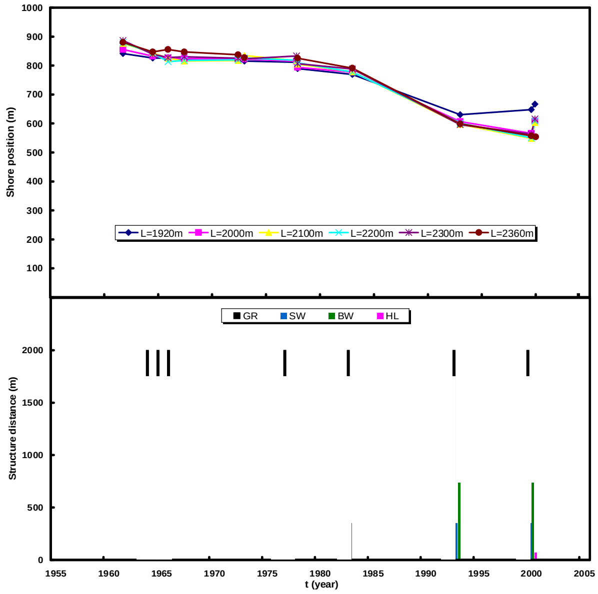

Fig.2 Shoreline position change of the sand spit at the Sagami River mouth and nearby coastal structures.

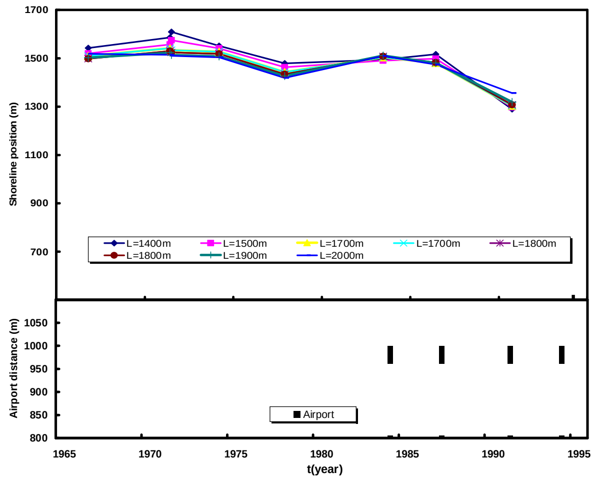

Fig.3 Shoreline position change of the sand spit at the Ohyodo River mouth and Miyazaki Airport.